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Inflation Dynamics in the New EU Member States: How Relevant Are External Factors?*

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Abstract

In this paper we evaluate the relative influence of external versus domestic inflation drivers in the 12 new European Union (EU) member countries. Our empirical analysis is based on the New Keynesian Phillips Curve (NKPC) derived in Galí and Monacelli (2005) for small open economies (SOE). Employing the Generalized Method of Moments (GMM), we find that the SOE NKPC is well supported in the new EU member states. We also find that the inflation process is dominated by domestic variables in the larger countries of our sample, whereas external variables are mostly relevant in the smaller countries.

Key words: New Keynesian Phillips Curve, small open economies, inflation dynamics, new EU member countries, GMM estimation.

JEL classification codes: C32, C52, E31, F41, P22.

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1 Introduction

This paper provides the first comprehensive empirical evidence on inflation dynamics in the new European Union member countries (NEUMCs), an issue with important and immediate policy implications. To forecast inflation and manage inflation expectations and to achieve (implicit) inflation targets central banks need to understand the inflation process. While this is valid everywhere in the world, the 10 former centrally-planned economies of Central and Eastern Europe and the 2 Mediterranean island-states forming up the NEUMCs pose a particular challenge. This is so because of the limited availability and quality of the data for this group of economies.

We estimate the small open economy New Keynesian Phillips Curve (SOE NKPC) based on the model by Galí and Monacelli (2005) to characterize inflation dynamics in the 12 NEUMCs. We choose this particular model because all countries in our sample can be classified as small open economies where external inflation drivers are potentially important. Thus, our primary goal in this paper is to disentangle and evaluate the relative influence of external versus domestic inflation drivers.

We have collected and constructed our own data set from various official sources, trying to ensure maximum length and methodological consistency for all 12 NEUMCs. For each of the 12 NEUMCs we estimate different specifications of the SOE NKPC by the Generalized Method of Moments (GMM). We find that the SOE NKPC performs reasonably well for nearly all NEUMCs. Our results indicate that the inflation process in four of the larger countries tends to be dominated by domestic variables, while in five of the smaller ones it is mostly affected by external variables.

Starting with Galí and Gertler (1999), many authors have analyzed inflation dynamics based on the NKPC.[1] However, only few papers analyze inflation dynamics in the Central and Eastern European countries. Using the Generalized Dynamic Factor Model due to Forni, Hallin, Lippi and Reichlin (2000), Stavrev (2009) quantifies the influence of common EU-wide drivers of CPI inflation in the 10 post-socialist NEUMCs (i.e., excluding Cyprus and Malta from our sample) at 65%. Hondroyiannis, Swamy and Tavlas (2008) estimate NKPCs for 7 NEUMCs and the euro area by GMM and Time-Varying Coefficient (TVC) techniques. Both cited papers use different closed economy specifications of the NKPC (in the case of Hondroyiannis, Swamy and Tavlas, 2008) or of the inflation process more generally (in the case of Stavrev, 2009). The point

[1] See, e.g., Galí, Gertler and López-Salido (2001, 2003, 2005), Rudd and Whelan (2005, 2006) and Sbordone (2002, 2005).

Hondroyiannis, Swamy and Tavlas (2008) are making is more methodological, focussing on how to deal with the transition. In contrast, we focus to a larger extent on the separation and analysis of internal versus external drivers of inflation. Apart from the methodological difference, their estimation uses the real unit labor cost as the proxy for marginal cost, while we use the output gap.

Our analysis is also closely related to the empirical literature that extends the standard New Keynesian Phillips curve to an open economy setting. Leith and Malley (2007) estimate an open economy NKPC for the G7 countries and Rumler (2007) for the euro area countries.

Mihailov, Rumler and Scharler (2010) present a similar analysis for a sample of developed OECD countries. The current paper extends this analysis to a new and unexplored data set. Our motivation for this paper also derives from an interest to see to what extent convergence of the NEUMCs has led to similarities with the Western EU countries in terms of what drives inflation, thus complementing our previous results. By evaluating via the same SOE NKPC equation the relative weight of domestic versus external inflation drivers, this sequel paper allows some comparable judgment as to how similar inflation dynamics in the NEUMCs are with respect to the (European) OECD countries.

The paper is further organized as follows. Section 2 outlines our empirical strategy, presenting the theory-derived equation we estimated and the data set. Section 3 reports and discusses our results, while the last section concludes the paper.

2 Empirical Strategy and Data

Our analysis is based on the model described in Galí and Monacelli (2005). From there, the CPI inflation rate, π_t, in a small open economy can be shown to follow

$$\pi_t = \beta E_t \pi_{t+1} + \lambda \widehat{mc}_t + \alpha \left(\Delta s_t - \beta E_t \Delta s_{t+1} \right), \tag{1}$$

where $\widehat{mc}_t$ denotes marginal production cost (in deviation from steady state), s_t is the (natural) log of the effective terms of trade of the SOE *vis-à-vis* the rest of the world, β is the standard time discount factor, and $\alpha \in [0, 1]$ is the share of imported goods in the household consumption bundle and, thus, a measure of trade openness.

Since $\widehat{mc}_t$ can be shown to be proportional to the SOE's output gap, x_t, the NKPC for the SOE can alternatively also be expressed as

$$\pi_t = \beta E_t \pi_{t+1} + \kappa_\alpha x_t + \alpha \left(\Delta s_t - \beta E_t \Delta s_{t+1} \right), \qquad (2)$$

where $\kappa_\alpha \equiv \lambda \left(\sigma_\alpha + \varphi \right)$, $\lambda \equiv \frac{(1-\beta\theta)(1-\theta)}{\theta}$, $\sigma_\alpha \equiv \frac{\sigma}{(1-\alpha)+\alpha\omega}$, and $\omega \equiv \sigma\gamma + (1-\alpha)(\sigma\eta - 1)$; furthermore, σ is the inverse of the intertemporal elasticity of substitution in consumption and φ is an analogous parameter characterizing the intertemporal labor/leisure choice, θ is related to the degree of price stickiness (as $1-\theta$ is the probability of adjusting prices in a Calvo (1983) setting), γ measures the substitutability between goods produced abroad, and $\eta > 0$ is the intratemporal substitutability in consumption between the SOE's domestically-produced and imported goods.

Equation (2) resembles the standard forward-looking NKPC where inflation is driven by expected inflation and the domestic output gap, but augmented with an additional term, the observed, current-to-past period change in the terms of trade (ToT) relative to the expected, next-to-current period discounted ToT change, $\Delta s_t - \beta E_t \Delta s_{t+1}$. Intuitively, an expected improvement in the ToT in the next relative to the current period ($\Delta s_t > \beta E_t \Delta s_{t+1}$) would increase current demand for domestic goods because their price is relatively lower than what is anticipated in the future, and this increased demand exerts upward pressure on current inflation. This pressure is stronger the higher is the degree of openness to trade, α. Inversely, an expected deterioration of the ToT in the next relative to the current period ($\Delta s_t < \beta E_t \Delta s_{t+1}$) would lower current-period demand for domestic goods as agents expect their relative price to decline in the future, and thus exerts downward pressure on current inflation.

Our empirical analysis is based on GMM estimation of equation (2).[2] Note that the terms of trade enter explicitly in the equation along with domestic drivers of CPI inflation. Therefore this equation is a natural starting point for a comparison of domestic and external factors relevant for inflation dynamics.

Due to limited data availability, we had to create our own quarterly data set, which underlies the estimation results in this paper. We combine information from different organizations that compile international and national time series in a regular and more or less harmonized fashion, such as the IMF (International Financial Statistics),[3] OECD (National Accounts),[4] Eurostat (National Accounts) and the national statistical offices of the new EU member countries. De-

[2] Although GMM is a standard methodology to estimate forward-looking models under the assumption of rational expectations, it is also subject to criticism. Hall et al. (2009) show that GMM can yield inconsistent results.

[3] Obtained online via the UK Economic and Social Data Service (ESDS).

[4] Via the ESDS too.

tailed definitions and sources of the NEUMCs time series we employed are provided in Appendix A. In this section we briefly summarize this information and compare the available data proxies across the countries in our sample.

Table 1: Data Availability

	No obs.	initial Q	final Q
Poland	50	1995q1	2007q2
Hungary	47	1995q1	2006q3
Czech Republic	53	1995q1	2008q1
Slovakia	53	1995q1	2008q1
Slovenia	53	1995q1	2008q1
Estonia	52	1995q1	2007q4
Latvia	53	1995q1	2008q1
Lithuania	53	1995q1	2008q1
Bulgaria	33	2000q1	2008q1
Romania	31	2000q1	2007q3
Cyprus	52	1995q1	2007q4
Malta	43	1995q1	2005q3

As can be seen from Table 1, our samples by country are in most cases of the order of about 50 quarterly observations, starting from the first quarter of 1995 for most countries. In the case of the post-socialist transition economies, 1995 is a good beginning of the sample because any earlier one would have resulted in more turbulence carried over from the highly volatile five years of initial reforms that implemented a huge structural change across these economies, invalidating econometric inference. In most countries this transitional excessive variability in institutions and in the economy had settled down by the mid-1990s, also with view to the envisaged EU accession and the preparatory work toward it. For comparability (and sometimes also data availability) reasons, it is not surprising that we opt for the same initial quarter in the case of the two non-ex-socialitst economies, Cyprus and Malta.[5] Because of the hyperinflationary episode in January-February 1997 that led to the currency board regime in Bulgaria in operation since July 1997, we prefer to start our sample for this country later, in fact from the first quarter of 2000 (due to better-quality GDP series). As for Romania, consistent data for the 1990s are not available (in particular, export and import price measures), so we were constrained to begin this country's sample in the first quarter of 2000 too. Overall, however, it has to be kept in mind, that the estimation samples are rather short and that the available data might be of somewhat limited quality. Thus, our estimation results have to be interpreted with a certain degree of

[5]For Cyprus the GDP deflator has been used as there was no CPI available. For Malta the sample ends a bit earlier because import and export price data run up to 2005.

caution.

We have separated on purpose our total sample of 12 small open economies into subgroups of countries that appear more similar with one another. This grouping reveals the logic we followed in the non-alphabetical ordering of the NEUMCs when reporting and discussing our estimates further down, identical to that in Table 1. Poland and Hungary started the reforms earlier than the other post-socialist countries; the Czech Republic and Slovakia were one country that split apart in 1993; Slovenia is the only member of former Yugoslavia, and is also the most advanced transition economy in terms of level of GDP per capita and standard of living; the three Baltic countries share similar historical and regional economic characteristics; likewise do Bulgaria and Romania, which were the 'laggards' in the ex-socialist group in terms of progress with the market and institutional pre-accession reforms; and, finally, Cyprus and Malta are small Mediterranean islands that were never socialist countries but were both colonies of the United Kingdom until quite recently. This grouping, we hope, may help our analysis and interpretation of the empirical results.

The largest difficulty in ensuring consistent data came from the proxies for the price indices of exports and imports (summarized in Table 2) needed to define the terms of trade and their expected change entering the estimated regressions. Our choice of variable proxies reported in the next section has thus mostly been motivated by the longest available ToT series – i.e., often the Eurostat data, whose other advantage would be the maximum comparability (arising from the harmonized underlying methodology). Since CPI data for most countries display clear signs of seasonality, we use seasonally-adjusted (sa) CPI data for all countries in our baseline specification. Our standard method of calculating the output gap is by subtracting the Hodrick-Prescott (HP) filtered trend.

3 Estimation Results

Starting from our baseline estimates of the seasonally-adjusted (sa) CPI, Hodrick-Prescott (HP) filtered output gap SOE NKPC specification in Table 3, the overall impression is that we obtain largely plausible results. However, the reported estimate of α for Hungary comes out significant at the 5% level with a negative value not allowed by theory. A similar problem occurs for the output gap coefficient, κ_α, for Romania where we also find a significant negative value. All other aspects of the regressions in Table 3 are econometrically and economically meaningful. β is always statistically significant at the 1% level for all 12 NEUMCs and shows plausible values

Table 2: Data Sources on Trade Prices

	xpi and mpi	xuv and muv	xpd and mpd
Poland	IMF, Eurostat	IMF	OECD
Hungary	IMF, Eurostat	IMF	OECD
Czech Republic	Eurostat, NS	-	OECD
Slovakia	Eurostat	-	OECD
Slovenia	Eurostat	-	NS
Estonia	Eurostat, NS	-	-
Latvia	Eurostat, NS	NS	-
Lithuania	Eurostat, NS	NS	-
Bulgaria	Eurostat, NS	-	NS
Romania	Eurostat	-	-
Cyprus	Eurostat	IMF	-
Malta	Eurostat	IMF, NS	-

Notes: NS denotes national source. xpi and mpi stand for export and import price indices, respectively; xuv and muv for export and import unit values; and xpd and mpd for export and import price deflators.

for most countries. From theory we expect values slightly smaller than unity which is consistent with our estimates including the confidence intervals, with the exception of Romania. Not counting the problematic value for Hungary, α comes out statistically significant for 8 countries, with a range from 0.01 (Romania, which with Poland is the largest economy relative to the remaining 10) to 0.28 (Cyprus). For three countries (Poland, Slovenia and Malta), α turns out to be insignificant. For the same countries the output gap does not come out as significant either, except for Poland at the 10% level. For the remaining countries the SOE NKPC performs quite well. The output gap coefficient is statistically significant for 7 countries, although for Romania, the point estimate is negative.

We checked the robustness of the reported baseline estimates by considering the same SOE NKPC version but estimated with non seasonally-adjusted (nsa) CPI data as well as an additional specification where the output gap was obtained using a quadratic polynomial (QP) instead of the Hodrick-Prescott (HP) filter. Our results (available upon request) indicate that the regression with nsa CPI data corrects the problem of negative α estimates for Hungary and Slovenia, yet at the same time producing negative estimates for Poland, Latvia, Cyprus and the Czech Republic, and that the coefficient on the output gap comes out negative in a larger number of countries than in the baseline estimation. From this robustness check we conclude that our central results remain valid also with alternative methods of detrending and non seasonally-adjusted data, but the econometric performance of the estimations deteriorates.

Next, we compare our baseline estimation with three alternative versions of the NKPC, which could be seen as a test of the Galí and Monacelli (2005) model against other common

Table 3: GMM Estimates of the SOE NKPC (sa CPI, HP gap)

	β		p-value	κ_α		p-value	α		p-value	p(J-stat)
Poland	1.00	***	0.00	0.10	*	0.05	0.01		0.47	0.74
Hungary	1.02	***	0.00	0.21	***	0.00	-0.03	**	0.04	0.89
Czech Rep.	0.94	***	0.00	0.13	***	0.00	0.10	**	0.02	0.88
Slovakia	0.99	***	0.00	0.00		0.91	0.03	***	0.00	0.90
Slovenia	1.04	***	0.00	-0.04		0.11	-0.02		0.11	0.74
Estonia	0.99	***	0.00	0.05		0.35	0.05	*	0.05	0.77
Latvia	0.96	***	0.00	0.28	***	0.00	0.03	***	0.00	0.87
Lithuania	0.90	***	0.00	-0.01		0.89	0.20	***	0.00	0.83
Bulgaria	0.95	***	0.00	0.31	***	0.00	0.14	***	0.00	0.86
Romania	1.12	***	0.00	-0.26	***	0.00	0.01	*	0.10	0.90
Cyprus	0.97	***	0.00	0.08	**	0.05	0.28	***	0.00	0.71
Malta	0.90	***	0.00	0.01		0.91	-0.00		0.94	0.67

Notes: Coefficients are estimated according to equation (2) with the sample period for each country corresponding to data availability. * denotes significance at the 10%, ** at the 5% and *** at the 1% level. Hansen's J-test tests the validity of the overidentifying restrictions imposed by the instruments with the null hypothesis that the overidentifying restrictions are satisfied (the instruments are valid). Standard errors are robust to heteroskedasticity and autocorrelation.

Table 4: GMM Estimates of the SOE NKPC with Differenced ToT (sa CPI, HP gap)

	β_Δ		p-value	$\kappa_{\alpha\Delta}$		p-value	α_Δ		p-value	p(J-stat)
Poland	0.99	***	0.00	0.07		0.15	0.00		0.99	0.69
Hungary	1.00	***	0.00	0.21	***	0.00	-0.01		0.67	0.83
Czech Rep.	0.97	***	0.00	0.13	***	0.00	-0.05		0.13	0.83
Slovakia	0.97	***	0.00	-0.03		0.50	0.03	**	0.02	0.94
Slovenia	1.03	***	0.00	-0.04		0.11	-0.00		0.81	0.73
Estonia	0.93	***	0.00	0.02		0.64	-0.04		0.27	0.64
Latvia	0.97	***	0.00	0.33	***	0.00	0.05		0.57	0.78
Lithuania	0.78	***	0.00	0.15	***	0.00	0.02		0.49	0.65
Bulgaria	0.95	***	0.00	0.39	***	0.00	0.28	***	0.00	0.84
Romania	1.01	***	0.00	-0.06	*	0.07	0.08	***	0.00	0.86
Cyprus	0.88	***	0.00	0.08	**	0.04	-0.17		0.13	0.88
Malta	0.91	***	0.00	0.00		0.95	0.00		0.47	0.84

Notes: Coefficients are estimated from $\pi_t = \beta_\Delta E_t \pi_{t+1} + \kappa_{\alpha\Delta} x_t + \alpha_\Delta \Delta s_t$ with the sample period for each country corresponding to data availability.

Table 5: GMM Estimates of the Closed Economy NKPC (sa CPI, HP gap)

	β		p-value	κ		p-value	p(J-stat)
Poland	0.97	***	0.00	0.08	*	0.09	0.90
Hungary	1.03	***	0.00	0.14	**	0.01	0.70
Czech Rep.	0.96	***	0.00	0.09	*	0.08	0.92
Slovakia	0.99	***	0.00	-0.00		0.94	0.81
Slovenia	1.04	***	0.00	-0.03		0.15	0.51
Estonia	0.96	***	0.00	0.10	**	0.01	0.78
Latvia	1.00	***	0.00	0.27	***	0.00	0.81
Lithuania	0.82	***	0.00	0.14	**	0.02	0.62
Bulgaria	1.05	***	0.00	0.16	*	0.07	0.77
Romania	1.09	***	0.00	-0.10	***	0.00	0.97
Cyprus	0.98	***	0.00	0.06	**	0.01	0.91
Malta	0.81	***	0.00	0.15	***	0.00	0.81

Notes: Coefficients are estimated from $\pi_t = \beta E_t \pi_{t+1} + \kappa x_t$ with the sample period for each country corresponding to data availability.

specifications of the NKPC. We start with an ‘empirically motivated’ SOE NKPC, where we essentially replace $(\Delta s_t - \beta E_t \Delta s_{t+1})$ in equation (2) with the first difference of the terms of trade, Δs_t. Estimation results are shown in Table 4. We see that this modification of our estimated equation seriously worsens the estimates for the coefficient α, of which now only 3 remain statistically significant. This result provides support in favor of the theory-consistent equation (2).

We proceed by estimating the ‘pure’ forward-looking closed-economy NKPC version. Results are reported in Table 5. The estimation of the pure closed-economy NKPC adds 3 countries (Estonia, Lithuania and Malta) where the output gap becomes statistically significant and positive relative to our baseline estimates of the SOE NKPC in Table 3. Thus, this pure closed-economy specification performs quite well, with only 2 countries (Slovakia and Slovenia) where the output gap remains insignificant. However, this specification does not deliver an answer to the question whether external or domestic factors dominate inflation dynamics in the NEUMCs.

We finally consider the ‘hybrid’ closed-economy NKPC version, whose estimates are reported in Table 6. This specification delivers reasonable parameter estimates for most countries even though the estimates of the forward-looking parameter, γ_f, look problematic particularly for Bulgaria and Romania. Yet it is worth noting that backward-looking behavior comes out statistically significant and economically meaningful in most NEUMCs, with γ_b ranging from 0.28 (Estonia) to 0.75 (Malta), ignoring the implausibly high values for Bulgaria and Romania. Our findings for this specification are, thus, similar to those typically reported in the literature. In particular, using both GMM and TVC estimation Hondroyiannis et al. (2008) also find for the 7 NEUMCs in their sample (as well as for the euro area), that inflation persistence appears low. Such results imply that, in general, accession of the countries in the region to the European Monetary Union (EMU) would not seriously impair the European Central Bank (ECB) in pursuing its objective of price stability once inflation expectations are anchored.

To compare the fit of the different specifications we employ the approach introduced by Galí and Gertler (1999) and Galí, Gertler and López-Salido (2001) which is frequently used in the literature.[6] They construct the inflation series implied by the present-value representation of the Phillips Curve and compare this series, which they call 'fundamental inflation', with actual inflation. The derivation of fundamental inflation for our application is outlined in Appendix C. We compare fundamental inflation and actual inflation using three different measures: the root mean square error (RMSE) between fundamental and actual inflation, the ratio of standard deviations of fundamental and actual inflation and the correlation of fundamental and actual inflation. For each of these measures we assign ranks to the different specifications. The resulting median rank scores are shown in Table 7. The detailed results underlying the rank scores are given in Table 8 in Appendix C.

Table 7 shows that according to the median rank scores the hybrid closed economy model in the last column of the table has the best fit of all models. It delivers a fundamental inflation series that shows the closest correspondence with actual inflation for 7 out of 12 countries. This has probably to do with the fact that fundamental inflation implied by the hybrid model also mirrors lagged inflation which produces a better fit than models without lagged inflation especially for high inflation countries. A similar result is found in Galí, Gertler and López-Salido (2001). The second-best model in terms of the fit of fundamental inflation across countries is our main specification in this paper, the Galí and Monacelli (2005) model. Here, fundamental inflation compares best to actual inflation for one country (Estonia) and ranks second for 5 countries. We conclude that the evaluation of the empirical fit of the different model types confirms our previous findings based on the coefficients estimates that the Galí and Monacelli (2005) model outperforms the modified model shown in Table 4 and the 'pure' forward-looking NKPC in Table 5.

Overall, our results from estimating the SOE NKPC for the NEUMCs appear reasonable

[6] The idea of evaluating the fit of rational-expectation models goes back to Campbell and Shiller (1987) who apply this method to evaluate asset price models.

Table 6: GMM Estimates of the Hybrid Closed Economy NKPC (sa CPI, HP gap)

	γ_f		p-value	γ_b		p-value	κ		p-value	p(J-stat)
Poland	0.56	***	0.00	0.42	***	0.00	0.01		0.73	0.84
Hungary	0.51	***	0.00	0.49	***	0.00	0.00		0.93	0.96
Czech Rep.	0.28	***	0.00	0.73	***	0.00	-0.11	***	0.01	0.88
Slovakia	0.68	***	0.00	0.33	***	0.00	-0.02		0.41	0.95
Slovenia	0.16		0.49	0.67	***	0.00	-0.16	***	0.00	0.55
Estonia	0.73	***	0.00	0.28	***	0.00	0.24	***	0.00	0.79
Latvia	0.55	***	0.00	0.48	***	0.00	-0.07		0.13	0.63
Lithuania	0.40	***	0.00	0.58	***	0.00	0.07		0.24	0.68
Bulgaria	-0.00		0.99	0.99	***	0.00	-0.34	*	0.07	0.72
Romania	-0.17	***	0.01	0.99	***	0.00	0.25	***	0.00	0.91
Cyprus	0.61	***	0.00	0.42	***	0.00	-0.00		0.86	0.88
Malta	0.28	**	0.01	0.75	***	0.00	-0.03		0.34	0.89

Notes: Coefficients are estimated from $\pi_t = \gamma_f E_t \pi_{t+1} + \gamma_b \pi_{t-1} + \kappa x_t$ with the sample period for each country corresponding to data availability.

Table 7: Median Rank Scores

	GM	GM Δs_t	CE	HYB
Poland	2	3	4	1
Hungary	4	3	2	1
Czech Republic	3	4	2	1
Slovakia	2	3	2	3
Slovenia	2	4	3	1
Estonia	1	2	3	4
Latvia	2	4	3	1
Lithuania	2	3	4	1
Bulgaria	3	2	2	2
Romania	3	2	3	1
Cyprus	4	2	3	2
Malta	3	1	2	3

Notes: GM denotes the Galí and Monacelli (2005) model (Table 3), GM Δs_t denotes the modified Galí-Monacelli model with Δs_t (Table 4), CE is the closed economy forward-looking model (Table 5), HYB is the closed economy hybrid model (Table 6).

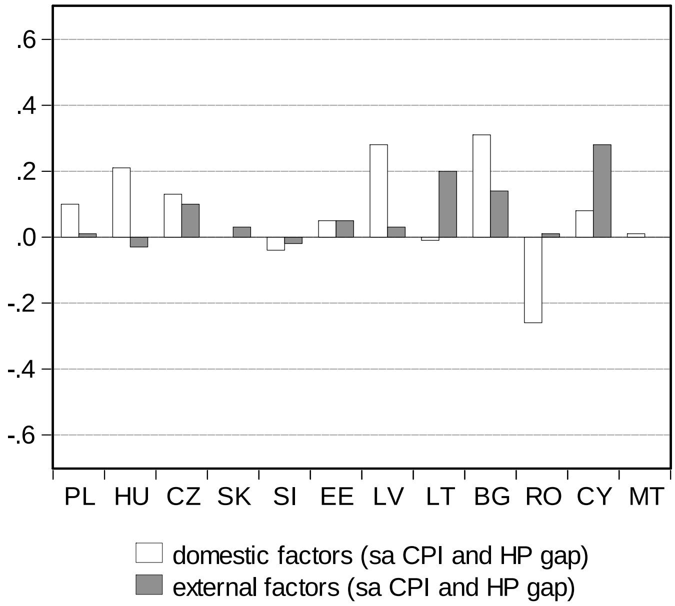
in general, as well as in comparison with the analogous estimates for the sample of 10 OECD countries in our earlier paper. Note, however, that the time series we used for Bulgaria, Romania, Cyprus and Malta, may suffer from weaker quality. A consequence of the inferior data may be the appearance of occasional negative significant (or sometimes insignificant) coefficients for the forward-looking parameter in the hybrid (Bulgaria, Romania and Cyprus) and pure (in the case of Cyprus only) closed-economy NKPC estimates.

Compared to our earlier paper, Mihailov, Rumler and Scharler (2010), on the 10 OECD countries, the results we report here indicate that the Galí and Monacelli (2005) SOE NKPC equation describes inflation dynamics relatively well for the NEUMCs when compared to the Western economies.[7] The domestic and external inflation drivers are jointly significant in about half of the NEUMCs as opposed to just one country (the UK) in our sample of OECD countries. This is somewhat surprising given the short time series which we employed to estimate the SOE NKPC for the NEUMCs. We would suggest two explanations for this interesting finding. First, due to the process of transition there has been greater macroeconomic volatility in the NEUMCs in the last decade and a half relative to the Western countries, which may have resulted in a more significant output gap coefficient in the inflation regressions. This is confirmed by the comparison of the standard deviations of the output gap between the two groups of countries which are on average about 10% higher in the NEUMCs than in our sample of 10 OECD countries. Second, stability-oriented monetary policy in the Western countries over the last two decades has contributed to the great macroeconomic moderation, and thereby to a decoupling of inflation from real economic activity reflected in the insignificant output gap coefficients we found. The absence of this effect in the NEUMCs has probably led to stronger output gap variations and thus to a significantly estimated effect of the output gap on inflation.

Concerning the relative importance of domestic versus external drivers of inflation dynamics, our results appear ambiguous, as shown in Figure 1. On the one hand, it seems that mostly domestic factors influence inflation dynamics in most of these countries (9 out of 12) for the baseline estimates from the sa-HP SOE NKPC specification. However, these findings do not pass convincingly the robustness check we implemented via the two (nsa-HP and nsa-QP) alternative specifications of the SOE NKPC. Generally, we may conclude that domestic determinants of inflation clearly dominate external ones in Poland, Hungary, Latvia and Bulgaria, and most likely in the Czech Republic. On the other hand, external inflation drivers clearly dominate

[7] In Mihailov, Rumler and Scharler (2010) the estimation samples differ somewhat due to limited availability, but run from 1970:1 to 2007:4 for most countries.

Figure 1: Domestic vs. External Drivers of Inflation



domestic ones in Slovakia, Lithuania and Cyprus, and most likely in Slovenia and Romania and perhaps in Estonia. These results differ somewhat from what is reported for the 9 Western EU members in our earlier work, where external factors generally played a stronger role.

The only relevant dimension of our SOE NKPC estimates which differentiates the new EU member states appears to be their (relative) size: the inflation process in 4 of the larger countries among the NEUMCs (Poland, Hungary, Bulgaria and Czech Republic) tends to be dominated by domestic factors, whereas 5 of the remaining smaller countries are mostly affected by external inflation drivers. Exceptions in terms of the relationship of size and dominance of external vs. domestic inflation drivers are only Latvia, which is a small country in the group of domestically-dominated inflation countries, and Romania, which is the largest country in the group of externally-dominated inflation countries.

We can summarize our findings as follows: Domestic determinants of inflation dominate external ones irrespective of the 3 open-economy specifications we estimated definitely in Poland, Hungary, Latvia and Bulgaria, and most likely in the Czech Republic, or 5 countries among the 12 NEUMCs. At the same time, external inflation drivers dominate domestic ones definitely in Slovakia, Lithuania and Cyprus, and most likely in Slovenia and Romania and perhaps in Estonia, or broadly speaking in the remaining half of our sample. Thus no clear pattern emerges indeed along a few possible dimensions of differentiated analysis, insofar both these groups include currency board countries (Latvia and Bulgaria versus Estonia), inflation targeting countries (Romania and Poland versus the Czech Republic), or non-ex-socialist (but ex-colonial) small island economies (Malta versus Cyprus). The only relevant dimension which differentiates the results from our SOE NKPC regressions by countries appears to be their relative size: the inflation process in 4 of the larger new EU member states (Poland, Hungary, the Czech Republic and Bulgaria) tends to be dominated by domestic factors; 5 of the remaining smaller territories (except Latvia but including Romania, which is the second largest NEUMC) are mostly affected by external inflation drivers.

4 Concluding Remarks

There are just a few studies that have assessed empirically inflation dynamics in the NEUMCs, and none of these focuses directly on the relative importance of external versus domestic determinants of inflation. However, policymakers in these countries need to understand better what type of factors influence the evolution of the price level when they forecast inflation and manage inflation expectations. It is, therefore, of immediate policy relevance to address this issue in an informed and robust way. This has exactly been the purpose of our present paper. Our empirical approach is based on the estimation of the widely-used New Keynesian SOE model of Galí and Monacelli (2005), as a way to achieve theoretical consistency of the estimated regressions. The estimation of this particular SOE NKPC model for the NEUMCs is the novelty of our paper.

Similarly to the findings in Mihailov, Rumler and Scharler (2010), the SOE NKPC is not unambiguously supported by the data in all 12 economies in our present NEUMCs sample. Nevertheless, it still tends to perform somewhat better than the alternative versions against which we checked our results. It is worth noting that, overall across the respective samples, the SOE NKPC enjoys stronger empirical support in our NEUMCs than in the Western EU/OECD economies. We explain this novel empirical result by a more variable output gap in the NEUMCs than in the Western countries due to the initial turbulence and institution-building of post-socialist (or post-colonial) transition.

Moreover, domestic factors tend to play a more important role in the larger countries of our sample while in the smaller countries external factors appear to be the more important inflation drivers. These findings differ somewhat from what we reported for the 10 OECD countries in our earlier paper, where external inflation determinants played a stronger role. Our result that the terms of trade are an important source of fluctuations in inflation suggests that especially the smaller countries in our sample may benefit from joining a currency area, to the extent that fixed nominal exchange rates lead to smoother fluctuations in the ToT. In this case, one would expect a less volatile inflation rate.

For the larger countries in the sample, domestic conditions are somewhat more relevant. As argued, among others, by Hondroyiannis et al. (2008), the slope of the NKPC determines how quickly shocks are transmitted into fluctuations in inflation. If these slopes are not sufficiently similar across countries, then a common monetary policy is likely to be welfare reducing. Although we find that the coefficients determining the reaction of the inflation rate to fluctuations in the domestic output gaps are quite heterogeneous across countries, this is also the case for the euro area countries included in the analysis in Mihailov, Rumler and Scharler (2010).

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A Definitions and Sources of the Data

All countries except Hungary and Malta

CPI is line 64...ZF in IMF/IFS (July 2008) quarterly series downloaded online via ESDS;
real GDP index is line 99BVPZF (2000=100) in IMF/IFS (July 2008) quarterly series downloaded online via ESDS;
MPI is from Eurostat quarterly database (2000=100, based on national currency, nsa) downloaded online from http://epp.eurostat.ec.europa.eu/portal/...;
XPI is from Eurostat quarterly database (2000=100, based on national currency, nsa) downloaded online from http://epp.eurostat.ec.europa.eu/portal/....

Hungary

CPI and real GDP index as for the other countries;
MPI is line 76.X.ZF in IMF/IFS (July 2008) quarterly series downloaded online via ESDS;
XPI is line 76...F in IMF/IFS (July 2008) quarterly series downloaded online via ESDS.

Malta

CPI and real GDP index as for the other countries;
MUV is from National Statistical Office quarterly database (2000=100) downloaded online;
XUV is from National Statistical Office quarterly database (2000=100) downloaded online.

B Instrumental Variables Used in the Estimations

In addition to the instruments below, each instrument set includes also a constant.

In Table 3:

Poland: seasonally adjusted CPI inflation lags 1 to 6, HP filtered output gap lags 1 to 4, change in terms of trade lags 1 to 4;
Hungary: seasonally adjusted CPI inflation lags 1 to 6, HP filtered output gap lags 1 to 6, change in terms of trade lags 1 to 4;
Czech Republic: seasonally adjusted CPI inflation lags 1 to 6, HP filtered output gap lags 1 to 6, change in terms of trade lags 1 to 4;
Slovakia: seasonally adjusted CPI inflation lags 1 to 6, real unit labor costs lags 1 to 6, change in terms of trade lags 1 to 4;

Slovenia: seasonally adjusted CPI inflation lags 1 to 6, HP filtered output gap lags 1 to 4, change in terms of trade lags 1 to 4;
Estonia: seasonally adjusted CPI inflation lags 1 to 6, HP filtered output gap lags 1 to 4, change in terms of trade lags 1 to 4;
Latvia: seasonally adjusted CPI inflation lags 1 to 6, HP filtered output gap lags 1 to 4, change in terms of trade lags 1 to 6;
Lithuania: seasonally adjusted CPI inflation lags 1 to 6, HP filtered output gap lags 1 to 4, change in terms of trade lags 1 to 4;
Bulgaria: seasonally adjusted CPI inflation lags 1 to 6, HP filtered output gap lags 1 to 4, change in terms of trade lags 1 to 4;
Romania: seasonally adjusted CPI inflation lags 1 to 6, HP filtered output gap lags 1 to 4, change in terms of trade lags 1 to 4;
Cyprus: seasonally adjusted CPI inflation lags 1 to 6, HP filtered output gap lags 1 to 4, change in terms of trade lags 1 to 4;
Malta: seasonally adjusted CPI inflation lags 1 to 4, HP filtered output gap lags 1 to 4, change in terms of trade lags 1 to 4.

In Table 4:

As in Table 3.

In Table 5:

As in Table 3.

In Table 6:

As in Table 3, but starting with lag 2 of CPI inflation.

C Comparison of Models

The model comparison is based on fundamental inflation. The detailed derivation of fundamental inflation for the standard NKPC is explained in Galí and Gertler (1999). Here we outline how fundamental inflation is constructed for our specifications which are extensions of the standard model.

We start with the forward-looking closed economy NKPC $\pi_t = \beta E_t \pi_{t+1} + \kappa x_t$. Solving the equation forward yields its present-value representation:

$$\pi_t = \kappa \sum_{s=0}^{\infty} \beta^s E_t \left[x_{t+s} \right]. \tag{3}$$

Computing fundamental inflation according to this expression requires multi-period forecasts of the output gap. Campbell and Shiller (1987) propose to generate them from a bivariate VAR. Thus, we calculate fundamental inflation for the closed economy (CE) model as

$$\pi_t^{CE} = \kappa e_1' \left(I - \beta A \right)^{-1} Z_t, \tag{4}$$

where A is the companion matrix of a VAR(1) on $Z_t = [x_t, \pi_t]'$ containing the output gap and inflation, I is the identity matrix and e_1' is a selection vector that singles out the forecast of the output gap, i.e. the first row of the resulting inverse matrix.

The Galí and Monacelli (2005) model which is analyzed in this paper extends the standard NKPC by including an additional term: $\pi_t = \beta E_t \pi_{t+1} + \kappa_\alpha x_t + \alpha \left(\Delta s_t - \beta E_t \Delta s_{t+1} \right)$. Note that the model can be rewritten as

$$\pi_t - \alpha \Delta s_t = \beta E_t (\pi_{t+1} - \alpha \Delta s_{t+1}) + \kappa_\alpha x_t. \tag{5}$$

Defining $y_t \equiv \pi_t - \alpha \Delta s_t$, equation (5) becomes $y_t = \beta E_t y_{t+1} + \kappa_\alpha x_t$. The forward solution of this equation yields the following present value formulation

$$\pi_t = \kappa_\alpha \sum_{s=0}^{\infty} \beta^s E_t \left[x_{t+s} \right] + \alpha \Delta s_t. \tag{6}$$

Applying the same principle as in the standard case, fundamental inflation for the GM model can be calculated as

$$\pi_t^{GM} = \kappa_\alpha e_1' \left(I - \beta A \right)^{-1} \tilde{Z}_t + \alpha \Delta s_t, \tag{7}$$

where the VAR is now estimated on the transformed vector $\tilde{Z}_t = [x_t, y_t]'$ containing the output gap and the transformed variable y_t.

For the extension of the Galí-Monacelli model that includes only the differenced ToT as an additional term, $\pi_t = \beta_\Delta E_t \pi_{t+1} + \kappa_{\alpha\Delta} x_t + \alpha_\Delta \Delta s_t$, the present value formulation is given as

$$\pi_t = \sum_{s=0}^{\infty} \beta_\Delta^s E_t \left[\kappa_{\alpha\Delta} x_{t+s} + \alpha_\Delta \Delta s_{t+s} \right]. \tag{8}$$

To empirically evaluate this expression we do not only need multi-step forecasts of the output gap but also of the differenced ToT which are jointly generated in a three dimensional VAR. Consequently, fundamental inflation of the GM Δs_t model can be calculated according to the expression

$$\pi_t^{GM\Delta s_t} = \kappa_{\alpha\Delta} e_1' \left(I - \beta_\Delta A \right)^{-1} \tilde{Z}_t + \alpha_\Delta e_2' \left(I - \beta_\Delta A \right)^{-1} \tilde{Z}_t, \tag{9}$$

where the VAR(1) is now estimated on the vector $\tilde{Z}_t = [x_t, \Delta s_t, \pi_t]'$ containing the output gap, the differenced ToT and inflation and e_2' is an additional selection vector selecting the forecast of Δs_t, i.e. the second row of the resulting inverse matrix.

Finally, the present value formulation of the hybrid closed economy NKPC, $\pi_t = \gamma_f E_t \pi_{t+1} + \gamma_b \pi_{t-1} + \kappa x_t$, is given by

$$\pi_t = \delta_1 \pi_{t-1} + \left(\frac{\kappa}{\delta_2 \gamma_f} \right) \sum_{s=0}^{\infty} \left(\frac{1}{\delta_2} \right)^s E_t \left[x_{t+s} \right], \tag{10}$$

where $\delta_1 = \frac{1-\sqrt{1-4\gamma_f\gamma_b}}{2\gamma_f}$ and $\delta_2 = \frac{1+\sqrt{1-4\gamma_f\gamma_b}}{2\gamma_f}$ are the stable and unstable roots of the reduced-form hybrid NKPC (see Galí and Gertler, 1999, for more explanation). Thus, fundamental inflation for the HYB model can be calculated as

$$\pi_t^{HYB} = \delta_1 \pi_{t-1} + \left(\frac{\kappa}{\delta_2 \gamma_f} \right) e_1' \left(I - \frac{1}{\delta_2} A \right)^{-1} Z_t, \tag{11}$$

with $Z_t = [x_t, \pi_t]'$. Note that, unlike for the forward-looking models, fundamental inflation for the hybrid model also includes lagged inflation.

Table 8: Model Comparison

	RMSE				Ratio of standard deviations				Correlation			
	GM	GM Δs_t	CE	HYB	GM	GM Δs_t	CE	HYB	GM	GM Δs_t	CE	HYB
Poland	1.23	1.25	1.43	0.77	0.32	0.31	0.19	0.83	0.78	0.72	0.63	0.91
Hungary	4.66	3.65	3.59	1.13	1.66	1.51	1.13	0.85	-0.30	-0.05	-0.39	0.87
Czech Rep.	1.14	1.32	0.92	0.97	1.07	1.33	0.79	0.96	0.38	0.36	0.48	0.49
Slovakia	1.20	1.27	1.19	1.54	0.09	0.14	0.05	0.61	0.26	-0.19	0.13	0.03
Slovenia	0.87	0.85	0.84	1.05	0.40	0.37	0.38	0.48	-0.70	-0.73	-0.71	0.29
Estonia	1.38	1.51	1.63	2.44	0.23	0.13	0.01	2.06	0.77	0.53	-0.63	0.88
Latvia	1.77	2.46	2.33	0.97	0.92	1.49	1.38	0.71	0.30	0.33	0.31	0.90
Lithuania	1.96	1.99	2.43	0.89	0.31	0.14	0.18	0.90	0.18	-0.04	-0.56	0.92
Bulgaria	1.95	2.00	1.68	1.52	0.02	0.05	0.03	0.04	0.44	0.44	0.53	0.15
Romania	4.00	3.81	7.09	6.31	0.47	0.34	0.59	0.87	0.32	0.44	0.35	0.59
Cyprus	0.55	0.45	0.48	0.51	0.75	0.55	0.48	0.71	-0.02	0.26	0.02	0.35
Malta	0.49	0.48	0.57	0.83	0.10	0.07	0.13	1.05	-0.16	0.01	-0.06	-0.06

Notes: GM denotes the Galí and Monacelli (2005) model (Table 3), GM Δs_t denotes the modified Galí-Monacelli model with Δs_t (Table 4), CE is the closed economy forward-looking model (Table 5), HYB is the closed economy hybrid model (Table 6). RMSE is the root mean square error of fundamental inflation compared with actual inflation, Ratio of standard deviations is the ratio of the standard deviations of fundamental inflation and actual inflation, and Correlation is the correlation of fundamental and actual inflation.